

**Citation:**

Appleby PN, Davey GK, Key TJ. Hypertension and blood pressure among meat eaters, fish eaters, vegetarians and vegans in EPIC-Oxford. *Public Health Nutr.* 2002 Oct; 5 (5): 645-654.

**PubMed ID:** [12372158](#)

**Study Design:**

Cross-sectional

**Class:**

D - [Click here](#) for explanation of classification scheme.

**Research Design and Implementation Rating:**

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

**Research Purpose:**

To compare the prevalence of self-reported hypertension and mean systolic and diastolic blood pressure in four diet groups (meat eaters, fish eaters, vegetarians and vegans) and to investigate dietary and other lifestyle factors that might account for any differences observed between the groups.

**Inclusion Criteria:**

- Between 1993 and 1999, 57,500 British men and women from the United Kingdom were recruited into the EPIC-Oxford cohort
- Recruitment from either general practitioner office or postal mailings.

**Exclusion Criteria:**

- Date of blood pressure measurement was unknown or incomplete
- Older than 80 years
- Missing values of the blood pressure measurements
- BMI was under 15kg per m<sup>2</sup> or over 60kg per m<sup>2</sup>.

**Description of Study Protocol:****Recruitment**

Between 1993 and 1999, 57,500 British men and women from the United Kingdom were recruited into the EPIC-Oxford cohort from either general practitioner office or postal mailings.

**Design**

- Based on food frequency questionnaire, groups divided into meat eaters, fish eaters,

- vegetarians and vegans
- Data analyzed among the groups.

### **Blinding Used**

Not applicable.

### **Intervention**

Not applicable.

### **Statistical Analysis**

- The analyses were separated into groups: Participants were categorized into one of 12 five-year age groups, according to their age at blood pressure measurement. Chi-square tests were used to assess the statistical significance of differences in prevalence among the diet groups.
- F-tests were used to determine any significance of the heterogeneity of blood pressures across the categories
- ANOVA was used to determine the relationship of blood pressures and differences in BMI, nutrient intake or other lifestyle factors.

### **Data Collection Summary:**

- *Timing of measurements:* At initiation of recruitment (between 1993 to 1999)
- *Dependent variables:* Diet type: Meat eater, fish eater, vegetarian, vegan
- *Independent variables:* Blood pressure measurements
- *Control variables:* Age, BMI

### **Description of Actual Data Sample:**

- *Initial N:* 57,500 initial recruits
- *N after exclusion:*
  - 2,351 men (996 meat eaters, 297 fish eaters, 786 vegetarians and 272 vegans)
  - 8,653 women (3,741 meat eaters, 1,431 fish eaters, 3,014 vegetarians and 467 vegans)
- *Attrition (final N):* 2,351 men and 8,653 women
- *Age:* 37 to 54 years (range of the various group means)
- *Ethnicity:* Not reported
- *Other relevant demographics:* Residents of the United Kingdom
- *Anthropometrics:* BMI between 15kg per m<sup>2</sup> and 60kg per m<sup>2</sup>
- *Location:* United Kingdom.

### **Summary of Results:**

#### **Hypertension**

- Meat eaters had the highest (20.7% for men, 16.5% for women) and vegans the lowest (5% for men, 6.8% for women) prevalence of hypertension. Fish eaters (12.1% for men, 10.7% women) and vegetarians (9.8% for men, 8.5% for women) took intermediate values.
- Among participants with no self-reported hypertension, there were statistically significant

variations in age-adjusted mean systolic blood pressure and diastolic blood pressure among the four diet groups for both men and women, with meat eaters having the highest values and vegans the lowest values

- However, in the multivariate analysis, diet group explained very little of the variation among groups
- BMI accounted for much of the age-adjusted variation in blood pressure among diet groups.

#### **Age-adjusted Mean (95% confidence interval) Systolic and Diastolic Blood Pressures in Men and Women with No Self-reported Hypertension by Body Mass Index**

	<b>Systolic Blood Pressure (mmHg)</b>		<b>Diastolic Blood Pressure (mmHg)</b>	
<b>Fifth of BMI</b>	<b>Men</b>	<b>Women</b>	<b>Men</b>	<b>Women</b>
<b>1 (lowest)</b>	120.2 (118.8-121.7)	116.0 (115.2-116.7)	73.5 (72.6-74.5)	71.5 (71.0-72.0)
<b>2</b>	124.9 (123.4-126.4)	118.1 (117.3-118.9)	75.9 (75.0-76.9)	72.3 (71.8-72.8)
<b>3</b>	125.2 (123.7-126.7)	118.7 (117.9-119.4)	77.2 (76.2-78.2)	72.9 (72.4-73.3)
<b>4</b>	126.8 (125.3-128.3)	121.2 (120.5-122.0)	78.3 (77.3-79.2)	74.4 (74.0-74.9)
<b>5 (highest)</b>	130.6 (129.1-132.1)	124.7 (124.0-125.5)	81.3 (80.4-82.3)	77.1 (76.6-77.6)
<b>Test of Heterogeneity</b>	P<0.0001	P<0.0001	P<0.0001	P<0.0001

- Median age at blood pressure measurement: 48 for men and 46 for women
- BMI was higher in the meat eaters than in the vegans
- Vegans consumed less saturated fatty acids and calcium, had a higher polyunsaturated fat to saturated fat ratio. Vegans were least likely to use salt in cooking or at the table compared to meat eaters. Vegans also had the highest activity level (exercising vigorously on a regular basis).

#### **Author Conclusion:**

- There were significant differences in the age-adjusted prevalence of self-reported hypertension among meat eaters, fish eaters, vegetarians and vegans for both men and women. Meat eaters had the highest and vegans the lowest prevalence of HTN, with fish eaters and vegetarians taking intermediate values.
- In the Western population, non-meat eaters, especially vegans, had a lower age-adjusted prevalence of self-reported hypertension and a lower blood pressure than did meat eaters. These differences were largely attributable to the lower BMI of the non-meat eaters.

#### **Reviewer Comments:**

### **Strengths**

- *Large number of observations, especially among vegetarians and vegans*
- *Large sample size among the groups.*

### **Limitations**

- *No standardized method of blood pressure measurement was utilized*
- *Hypertension was self-reported.*

## **Research Design and Implementation Criteria Checklist: Primary Research**

### **Relevance Questions**

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	N/A

### **Validity Questions**

1.	<b>Was the research question clearly stated?</b>	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	<b>Was the selection of study subjects/patients free from bias?</b>	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes

<b>3.</b>	<b>Were study groups comparable?</b>	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	Yes
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
<b>4.</b>	<b>Was method of handling withdrawals described?</b>	N/A
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
<b>5.</b>	<b>Was blinding used to prevent introduction of bias?</b>	No
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	No
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	No
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A

5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
<b>6.</b>	<b>Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were intervening factors described?</b>	<b>Yes</b>
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
<b>7.</b>	<b>Were outcomes clearly defined and the measurements valid and reliable?</b>	<b>No</b>
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	No
7.5.	Was the measurement of effect at an appropriate level of precision?	???
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	???
<b>8.</b>	<b>Was the statistical analysis appropriate for the study design and type of outcome indicators?</b>	<b>Yes</b>
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes

8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
<b>9.</b>	<b>Are conclusions supported by results with biases and limitations taken into consideration?</b>	<b>Yes</b>
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
<b>10.</b>	<b>Is bias due to study's funding or sponsorship unlikely?</b>	<b>Yes</b>
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes

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